

Claims

What is claimed is:

1. A system for monitoring the condition of a pump driven by a motor, comprising:
a sensor operatively coupled to a power lead of the motor, the sensor adapted to obtain at least one current signal relating to the operation of the pump; and
an artificial neural network operatively coupled to the sensor, the artificial neural network being adapted to detect at least one fault relating to the operation of the pump from the at least one current signal.
2. The system of claim 1, wherein the sensor is a current transformer.
3. The system of claim 1, wherein the artificial neural network is an unsupervised neural network
4. The system of claim 3, wherein the unsupervised neural network is a one-shot unsupervised neural network.
5. The system of claim 1, further including a processor operatively coupled to the sensor, the processor adapted to generate fast fourier transforms of the at least one current signal.
6. The system of claim 6, wherein the processor is adapted to create a fault signature from a current spectrum created from the fast fourier transformation of the at least one current signal wherein the fault signature contains distinguishable attributes relating to faults of the pump.

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7. The system of claim 1, wherein the processor is adapted to preprocess the fault signature by eliminating outliers, and performing scaling and bifurcation of the fault signature data set.

8. The system of claim 1, wherein the artificial neural network is also adapted to detect at least one fault relating to the operation of the motor from the at least one current signal.

9. A method for monitoring the condition of a pump driven by a motor, comprising the steps of:

collecting a first sample of current data signal relating to the operation of the pump;

inputting the first sample of current data signal to a neural network,

collecting a second sample of current data signal relating to the operation of the pump; and

inputting the second sample of current data signal to the neural network, wherein any differences between the first signal and the second signal will be generated as a change in condition signal by the neural network, any change of condition signal representing a pump fault condition.

10. The method of claim 9, wherein the step of collecting at least one sample of current data signal relating to the operation of the machine is accomplished by employing a current transformer.

11. The method of claim 9, wherein the artificial neural network is an unsupervised neural network.

12. The method of claim 9, wherein the unsupervised neural network is a one-shot unsupervised neural network.

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13. The method of claim 9, wherein the first sample of current data is a training sample for training the neural network.

14. The method of claim 9, wherein the first and the second sample of current data is transformed to a frequency spectrum by fast fourier transformation.

15. The method of claim 14, wherein the frequency spectrum is transformed to a fault signature and the fault signature is preprocessed by eliminating outlayers, and performing scaling and bifurcation of the fault signature before being fed to the neural network.

16. The method of claim 15, wherein output of the neural network is post processed to determine the specific fault condition represented by a change of condition signal.

17. The method of claim 16, wherein the step of post processing includes comparing the specific fault condition to fault attributes found in a fault signature of the pump.

18. The method of claim 1, wherein the artificial neural network is also adapted to detect at least one fault relating to the operation of the motor from the at least one current signal.

19. A stand alone decision module adapted to receive a current signal from a machine and facilitate diagnosing the state of the machine by determining if the current signal contains fault data relating to the state of the machine, the decision module comprising:

a neural network operatively coupled to a sensor, the neural network adapted to synthesize a change in condition signal from the sampled current data;

a preprocessing portion operatively coupled to the neural network, the preprocessing portion adapted to condition the current signal prior to inputting the current signal into the neural network; and

a post processing portion operatively coupled to the neural network, the post processing portion adapted to determine whether the change in condition signal is due to a fault condition related to the state of the machine.

20. The module of claim 19, wherein the artificial neural network is an unsupervised neural network.

21. The module of claim 20, wherein the unsupervised neural network is a one-shot unsupervised neural network.

22. The module of claim 21, wherein the paradigm of the neural network is of the type ART2 (Adaptive Resonance Theory).

23. The module of claim 21, wherein the paradigm of the neural network is Associative List Memory.

24. The module of claim 19, wherein the post processing portion is a fuzzy rule based expert system.

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25. The module of claim 19, wherein the module is adapted to detect at least one fault relating to the operation of a pump driven by the machine and at least one fault relating to the operation of the machine driving the pump from the current signal generated by the machine.

26. A system for simultaneously monitoring the condition of a pump driven by a motor and the condition of the motor driving the pump, comprising:

a sensor operatively coupled to a power source of the motor, the sensor adapted to obtain at least one current signal relating to the operation of the pump and the operation of the motor; and

an artificial neural network operatively coupled to the sensor, the artificial neural network being adapted to detect at least one fault relating to the operation of the pump and at least one fault relating to the operation of the motor from the at least one current signal.

27. The system of claim 26, wherein the artificial neural network is an unsupervised neural network

28. The system of claim 27, wherein the unsupervised neural network is a one-shot unsupervised neural network.

29. The system of claim 28, wherein the paradigm of the neural network is Adaptive Resonance Theory.

30. The system of claim 28, wherein the paradigm of the neural network is Associative List Memory.

31. The system of claim 26, further including a processor operatively coupled to the sensor, the processor adapted to generate fast fourier transforms of the at least one current signal.

32. A system for diagnosing a plurality of pumps, each driven by a motor, comprising:

a plurality of sensors for obtaining current data signals from each motor;

a channel interface operatively coupled to the plurality of sensors, the channel interface designating a separate channel for each of the plurality of sensors; and

a host computer operatively coupled to the channel interface, the host computer including a neural network operatively coupled to each channel of the channel interface, the neural network adapted to detect at least one fault relating to the operation of the plurality of pumps from the current data signals, wherein a processor of the host computer cycles through each of the channels, the processor performing classical signature analysis on each of the plurality of pumps using the current data signal for each respective pump.

33. A system for monitoring the condition of a pump driven by a motor, comprising:

means for detecting at least one current signal from the motor, said at least one current signal containing fault attributes related to the condition of the pump;

means for extracting the fault attributes from the at least one current signal;

means for determining if the fault attributes signify a fault condition of the pump;

and

means for communicating any fault conditions to a system operator.

34. The system of claim 33, wherein processing means for determining includes an unsupervised neural network.

35. The system of claim 34, wherein the unsupervised neural network is a one-shot unsupervised neural network.

36. A system for monitoring the condition of a pump driven by a motor, comprising:

a sensor operatively coupled to a power lead of the motor, the sensor adapted to obtain at least one current signal relating to the operation of the pump;

a processor operatively coupled to the sensor, the processor adapted to convert the at least one current signal to a frequency spectrum having a plurality of fault attributes related to the condition of the pump and preprocess the fault attributes;

an unsupervised artificial neural network operatively coupled to the processor, the artificial neural network being adapted to recognize and detect changes in the plurality of preprocessed fault attributes and provide a change of condition pattern relating to changes in the plurality of preprocessed fault attributes; and

a post processor including decision making rules for determining fault conditions of the pump based on the change of condition pattern, the post processor communicating any fault conditions to a system operator.

37. The system of claim 36, wherein the unsupervised neural network is a one-shot unsupervised neural network.

38. The system of claim 36, wherein the paradigm of the neural network is Adaptive Resonance Theory.

39. The system of claim 36, wherein the paradigm of the neural network is Associative List Memory.

40. The system of claim 36, wherein the post processor is a fuzzy rule based expert system.

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41. The system of claim 36, wherein the system is adapted to detect at least one fault relating to the operation of a pump driven by the machine and at least one fault relating to the operation of the machine driving the pump from the current signal generated by the machine.